

## **MEMORANDUM**

TO: Dave Stewart, PE / Jeff Bowra, PE  
DATE: November 27, 2019  
FROM: Robert Koechert / John Simon / Steve Britt  
PROJECT: Paxton Creek Interceptor Rehabilitation  
JMT JOB NO.: 16-2103-007  
RE: Phase 2 Rehabilitation Memorandum - Final

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### **PROJECT BACKGROUND**

The Paxton Creek Interceptor (PCI), owned and operated by Capital Region Water (CRW), was constructed in 1902 as a cast-in-place concrete conduit that comprises a combination of parabolic arch and rectangular-shaped pipes along Paxton Creek in Harrisburg, Pennsylvania. A previous rehabilitation method for the PCI used centrifugally cast cementitious pipe lining (CCCPL) and was halted with limited portions repaired due to issues involving groundwater infiltration and the effectiveness of the rehabilitation. The initial repair attempt is shown as Phase 1 in Figure 1.

CRW requested Johnson, Mirmiran & Thompson (JMT) to evaluate replacement and rehabilitation construction technologies to determine a cost-effective approach to restoring the structural integrity while maintaining the hydraulic capacity of the PCI. JMT submitted the Phase 2 Technology Evaluation Memo on December 27, 2018 recommending CRW consider both open-cut replacement and sliplining. The following methodologies were not selected due to the following reasons:

- ∞ Cured-in-Place Pipe (CIPP) – heavy infiltration within the PCI and an uncertain amount of grout to stop infiltration; a full wet weather bypass, and the number of additional access pits due to shorter lengths of CIPP.
- ∞ Centrifugally Cast Cementitious Polymer Mortar Lining (CCCPL) – undetermined amount of grout to stop heavy infiltration, unknown invert condition and infiltration preparation required, unknown long term effects of groundwater intrusion on CCCPL, and a full wet weather bypass would be required in order to decrease delays resulting from re-cleaning the pipe after wet weather events.
- ∞ Spiral-wound Pipe Lining – this yielded the most expensive trenchless technology evaluated, non-circular lining requires expensive structural grout which is complex to design due the heavy infiltration, dry weather bypass pumping required due to limited interior space for workers, slow production time, and a limited selection of licensed contractors.

Due to the variability of several key factors affecting the cost, schedule and feasibility of these approaches, JMT also recommended that CRW consider further analysis on the pipe's alignment and sliplining shape with a virtual mandrel assessment; perform preliminary environmental screening of the potentially affected properties; and estimate property easement costs for a new alignment. Although separate memorandums were submitted to CRW on the environmental screening and

property valuations, brief summaries of those efforts were incorporated into portions of this memorandum.

The portion of the PCI under evaluation extends from north of Maclay Street behind the Farm Show Complex southeast beyond Paxton Street (see Figure 1), totaling approximately 13,000 linear feet (LF) with a combination of three varying cross-sections. The combined sewer system conveys sanitary sewage and stormwater flows during wet weather events to the Front Street Pumping Station.

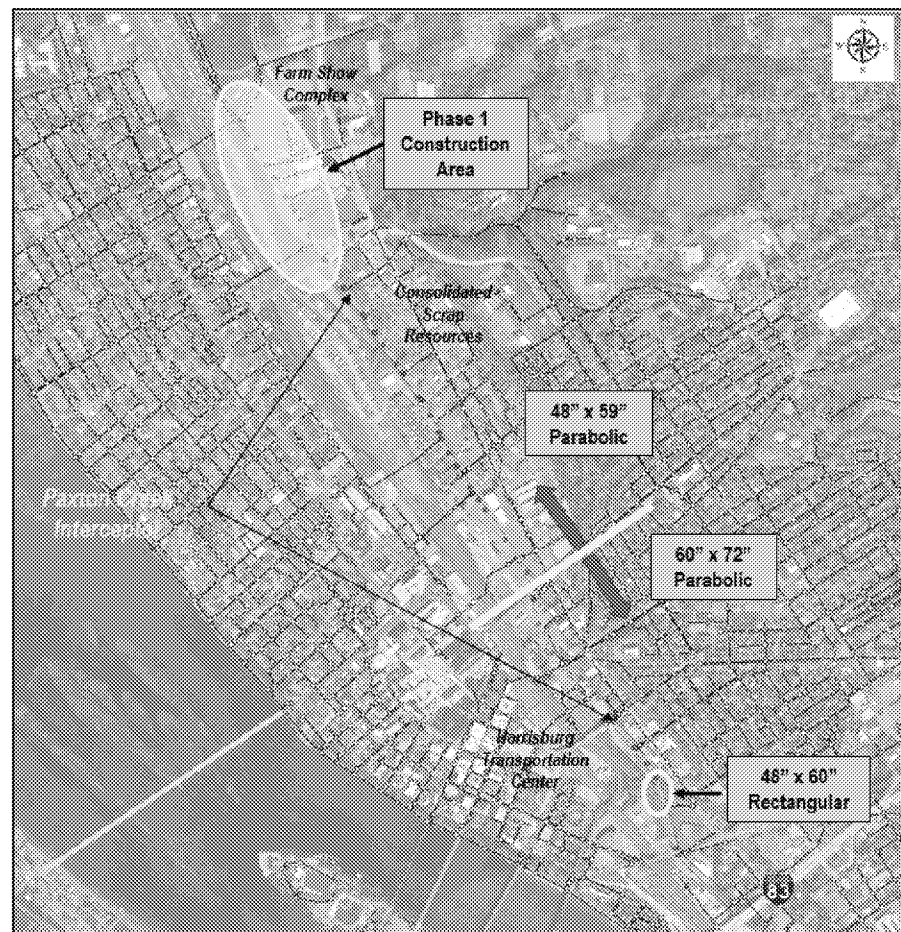
The purpose of this memorandum is to refine previous analyses given the results of the property evaluations, environmental screening, and virtual mandrel assessment.

## PIPE SLIPLINING

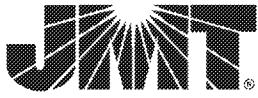
Sliplining is a trenchless approach to pipe rehabilitation that inserts or slips a new pipe within the existing host pipe to restore structural integrity to the system. Although considered a trenchless installation, sliplining does require intermittent excavations for insertion and receiving pits spaced along the alignment of the existing pipeline.

Contractors can take advantage of one access pit to push pipe in either direction. The more horizontal changes in the existing pipe's alignment, the more pits needed to install the pipe. Sliplining techniques commonly utilize either high-density polyethylene (HDPE) or fiber reinforced pipe (FRP) as the inserted pipe

material. FRP was utilized for this evaluation and is typically preferred when hydraulic capacity limitations are critical due to its thinner wall thickness. While circular FRP is available within six to eight weeks from order, non-circular FRP can take up to four months to receive after ordering takes place. Non-circular FRP is currently manufactured in Europe (Amiblu/HOBAS) and Asia (Channeline) and is considered custom order, making non-circular more expensive than circular pipe.



*Figure 1: Paxton Creek Interceptor Overview*



Sliplining allows for installation of the pipe during active dry weather flow in the pipe, thus minimizing the need for bypass pumping. During wet weather events, the contractor can secure the site and remove personnel until the flows reduce to a safe level for the work to continue. Most of the construction time centers around the access pit construction, grouting of the annular space and connection of the laterals. Due to the excessive infiltration in portions of the PCI, specialty, high density grout may be required to displace the groundwater. Additionally, each connection to the interceptor will need to be evaluated on a case to case base for its re-connection to the main. Some laterals may be able to be replaced using trenchless methods such as cured-in-place pipe (CIPP) or the installation of a PVC sleeve from the inside of the sliplining pipe. Others will require excavation and a point repair to re-connect to the PCI.

## **PIPELINE INSPECTION AND VIRTUAL MANDREL ANALYSIS**

JMT sub-contracted with Redzone Robotics, Inc. (Redzone) to inspect the PCI with Multi-Sensor Inspection (MSI) digital scanning equipment that utilizes a combination of digital CCTV, sonar, and laser profiling. The sonar combined with laser profiling creates a three-dimensional model of the PCI that is used by Redzone analysts to produce four reports that assist with the sliplining design: MSI Reports, Bend Radius Reports, Virtual Mandrel Reports, and Annulus Reports. The information in these reports will be used to determine sliplining pipe size, configuration, access pit locations, lateral locations, and areas requiring specialty bends or alternate installation methods. Table 1 provides a summary of each report and its function through the evaluation process. Each will be described in more detail in subsequent portions of this memo.

*Table 1: Redzone Report Information*

<b>Report Name</b>	<b>Corresponding Information Use</b>	<b>Information Provided As</b>
MSI Report (Multi-Sensor Inspection)	CCTV, sonar and laser profiling which shows pipe cross-sectional area loss and forms basis for all reports	Appendix A
Bend Radius Reports	Location of all horizontal bends used in the Virtual Mandrel Reports	Appendix B
Virtual Mandrel Reports	Utilizes the Bend Radius Reports to simulate sliplining and gives the maximum lengths of connected pipe for a chosen cross-section of sliplining pipe	Appendix D
Annulus Reports	Identifies the annular space and potential conflicts between the sliplining and host pipe	Appendix E

JMT coordinated with numerous property owners along the PCI to ensure crews could access all the manholes required to complete the inspection during March, May, and June of 2019. Redzone utilized their Responder robot to survey the PCI, shown in Figure 2. JMT reviewed CRW's flow meter data and coordinated with Redzone to ensure laser inspection did not take place with flows over 50% of the pipe height. Since the laser profiling only occurs above the water elevation, JMT required that this maximum flow depth be maintained to ensure the sufficient laser profiling was attained. Further reduction of flow would have required bypass pumping which was not considered for this evaluation. Below the water level, Redzone's equipment utilizes sonar data to survey the pipe shape, which is less accurate than the laser scanning. The majority of the surveys were performed at night during low

flow periods in the PCI. Depths of flow ranged from 12 inches in the smaller conduit to 24 inches in the larger sewer.

The Responder performed a CCTV and sonar inspection as the unit traveled away from the launching manhole, and performed the laser scan every two feet as it retracted back to the launching manhole. The inspections totaled approximately 1,200 LF per launch. Due to restricted access, crews utilized nine set-up locations with some manholes serving as the set-up location for multiple nights of inspection.

The CCTV inspection revealed that portions of the CCCPL sections that were previously rehabilitated (Phase 1) were still showing signs of heavy infiltration. JMT submitted these videos to CRW as they were received to alert CRW of the defects. JMT assumed these areas would be sliplined with the entire pipeline for consistency in rehabilitation and life expectancy.

Using the information collected by the sonar and the laser inspection, Redzone created a three-dimensional model of the PCI. This model and subsequent MSI and Bend Radius Reports enabled Redzone analysts to develop the existing pipe's average observed shape. These reports indicate pipe cross-sectional area loss due to erosion and/or corrosion of the pipe walls. The loss of pipe wall will not be a hinderance on sliplining but inconsistency in wall thickness may increase the amount of grout required to fill the annular space. The MSI Reports were included as Appendix A.

The Bend Radius Reports created by Redzone illustrated the presence and location of bends that are all at least more than one (1) degree. These reports were included in Appendix B and form the basis for the Virtual Mandrel Reports.

## **SLIPLINING PIPE SHAPE SELECTION**

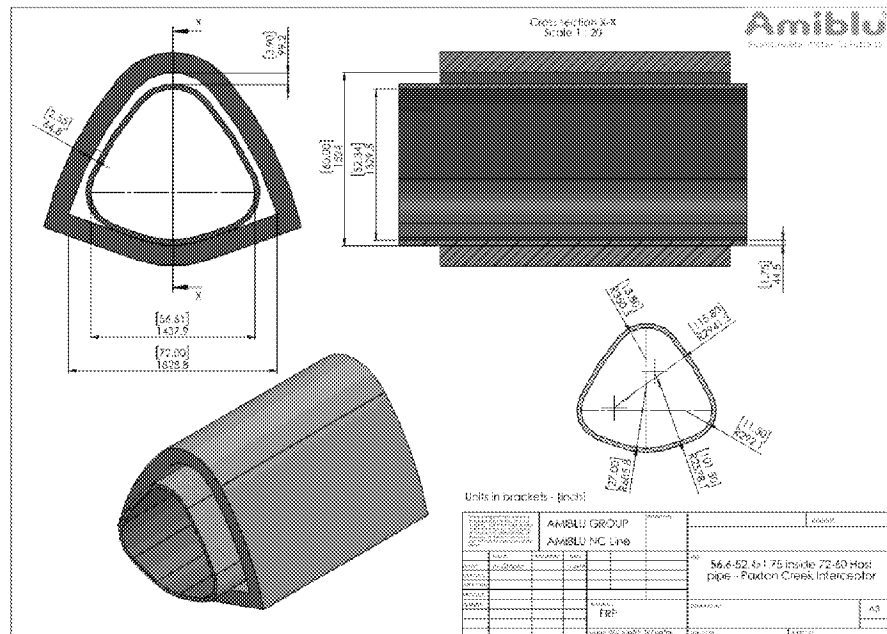
Based on the original construction drawings for the PCI, JMT coordinated with the two available pipe vendors, Amiblu/HOBAS and Channeline, to determine preliminary sliplining cross-sectional shapes. Figure 3 illustrates the smaller non-circular pipe shape provided by AmiBlu during preliminary analysis.

In a previous study performed by JMT, Amiblu's non-circular cross sections were selected for hydraulic analysis which was conducted by CRW's modeling consultant (CDM Smith) along with circular pipes as a comparison. CDM Smith performed model simulations for the sliplining shapes and submitted a memo dated November 30, 2018. Their findings indicated that a 33-inch circular slipliner was sufficient for the hydraulic capacity requirements of the PCI in the upstream section until Combined Sewer Overflow (CSO) 28 at Herr Street. Downstream of CSO-28, a non-circular slipliner was required in order to maximize the hydraulic capacity.



*Figure 2: Redzone Responder Unit*

The circular pipe will be flush bell-sliplining pipe rated for sliplining installation. For purposes of the Virtual Mandrel Analysis, HOBAS' 34-inch diameter OD pipe (33-inch nominal pipe size) was selected along with non-circular AmiBlu/HOBAS pipe consisting of three cross-sectional shapes shown in Table 2. The non-circular pipe thickness was determined by HOBAS using a finite element analysis, which yielded a 1.5-inch wall



*Figure 3: Smaller Diameter Non-Circular Pipe*

thickness for the small parabolic and rectangular shapes and a 1.75-inch wall thickness for the large parabolic shape. The cut-sheets of the selected pipes can be found in Appendix C.

*Table 2: Sliplining Pipe - Internal Diameters*

Existing Pipe Shape (HxW), inches	Proposed Circular ID, inches	Proposed Non-circular ID (HxW), inches
Small Parabolic, 48 x 59	32.26	40.8 x 42.5
Large Parabolic, 60 x 72	n/a	52.4 x 56.6
Rectangular 48 x 60	n/a	41 x 53

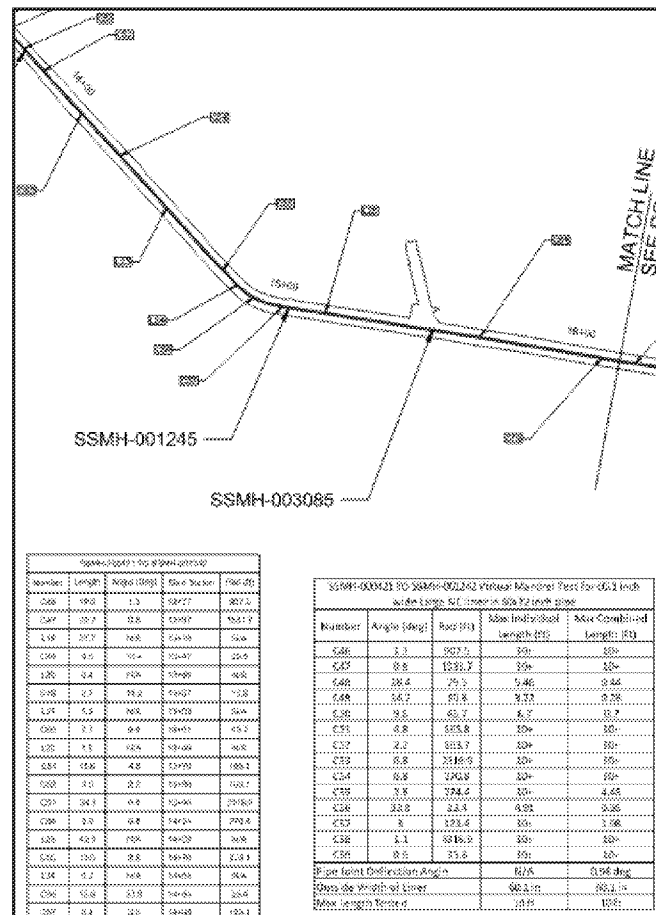
## VIRTUAL MANDREL RESULTS

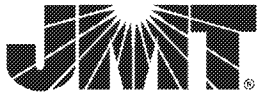
Redzone produced Virtual Mandrel Reports which simulated the sliplining installation using the three-dimensional model of the PCI and the sliplining pipe shapes provided by JMT. The mandrel test determines first, if an individual sliplining pipe will fit through the host pipe (Max Individual Length) and, subsequently, if multiple joined pipe segments will fit through the host pipe (Max Combined Length). For standard sliplining installation, the sliplining pipes are joined within the access pit and pushed into the host pipe; therefore, the Max Combined Length dictates whether standard sliplining with the typical pipe length can be used.

Redzone tested the PCI using 10-foot long pipe segments. This is more conservative than the actual 8-foot pipe lengths of non-circular pipe that would be used during installation. The Virtual Mandrel Reports were provided as Appendix D<sup>1</sup>.

The Virtual Mandrel Reports identified 13 locations where the Max Combined Length is less than the standard 8-foot or 10-foot pipe segment. These areas will require specific design and installation procedures. The simplest and most cost-effective design is to locate access pits at these areas and custom pipe segments can be manufactured and be directly installed in the pit after sliplining upstream and downstream. Alternately, smaller sections of pipe can be custom ordered to navigate the curved sections of the host pipe. These smaller pipe segments are more expensive than the standard 8-foot lengths and may slightly increase the construction cost of the project.

If neither of these options provide the most effective solution, an alternative rehabilitation technology will be considered such as open cut replacement or CIPP.





wide PE is estimated to cost \$858,668 and a 20-foot wide TCE is estimated to cost \$229,212. Compensation for Permanent Utility Easement was based on 50% of the fee simple value and compensation for the Temporary Construction Easements was based on 20% of the fee simple value. We assumed that any work done in a public right-of-way would be completed through a road opening permit at no cost and that no easement would be needed.

## **ENVIRONMENTAL SCREENING**

JMT's subconsultant Brightfields completed an Environmental Screening report submitted to CRW on May 15, 2019. The report summarized the findings of a review of available literature regarding environmental conditions within the proposed Paxton Creek Interceptor. This review was intended to identify areas and sites of potential environmental concern that could possibly impact the project, particularly for the construction of a new pipe. However, this information would also apply to sliplining for excavations related to access pits, lateral connections, structure modifications, and other constructability needs of the project. This high-level screening identified numerous properties of potential concern during construction.

In general, historic transportation and heavy industrial activities in the corridor present an area-wide environmental concern. Specifically, heavy industrial facilities including railroad shops and storage yards, a scrap handling company, railcar manufacturing companies, parts manufacturing companies, and a power generation station are known to have operated within or adjacent to the proposed project area. Results of previous investigations on several of these facilities indicate historic operations have resulted in soil and groundwater being contaminated with petroleum constituents, chlorinated solvents, and metals. In addition, light industrial operations in the area (brickyards, consumer goods manufacturers, builder suppliers, and tanneries), and automobile repair and paint shops may have also contributed to impacts to soil and groundwater.

In addition, the report identified that the areas surrounding Paxton Creek were originally marshes and which were subsequently filled and graded to a suitable elevation using materials available at the time, which likely included slag and cinders. Regulated organic and inorganic substances such as petroleum hydrocarbons and heavy metals are frequently encountered in historic fill. Those same regulated substances, in addition to pesticides and polychlorinated biphenyls (PCBs), are also frequently encountered in and surrounding historic transportation corridors where mechanical operations were conducted, treated wood was used or stored, or where coal and/or other potentially toxic materials were historically deposited. Paxton Creek was historically subject to severe flooding and several flooding events are reported to have caused significant damage to industrial operations and subsequent releases of regulated substances.

Health and safety requirements should be continuously evaluated as environmental conditions may vary across the site. The most cost-effective way to handle impacted soil or soil-like material (i.e., slag, fill, etc.) is to reuse it onsite. If excavated soil cannot be reused onsite, it may need to be treated or disposed of at an offsite facility. If dewatering is required, the most cost-effective way to address impacted groundwater is to pump water through a treatment system prior to discharge. If groundwater cannot be treated onsite to meet discharge requirements, it may need to be containerized and treated or disposed of at an offsite facility. If offsite treatment or disposal is required for soil and/or groundwater, samples of each media will need to be collected and analyzed for waste characterization parameters. Specialized training, additional PPE, and contaminated materials management may be necessary for this project. In order to qualify for certain grants and



funding, Phase I property assessments may need to be completed for properties where construction activities will occur. However, this may not yield further clarification on what contamination will be encountered during construction. In order to fully understand the environmental constraints, Phase II environmental assessments may need to be completed.

## SCHEDULE – COMPOSITE SLIPLINING

JMT anticipates design, bid, and easement acquisition for the composite sliplining rehabilitation of the PCI to take approximately 18 months. Subsequently, the construction will take approximately 21 months. This schedule will be affected by the amount of time it takes to acquire the required permits, property access agreements, and assess environmental areas of concern.

Description	2020				2021				2022				2023
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Project Design													
Property Acqn. / Environmental													
Bid and Award													
Construction													

Figure 5: Anticipated Project Schedule

## SCHEDULE – OPEN CUT PIPE REPLACEMENT

JMT anticipates design, bid, and easement acquisition for the open cut pipe replacement of the PCI to take approximately 30 months. Subsequently, construction will take approximately 36 months. This schedule will be affected by the amount of time it takes to acquire the required permits, permanent and temporary easements, and assess environmental areas of concern.

Description	2020		2021		2022		2023		2024		2025	
Project Design												
Property Acqn. / Environmental												
Bid and Award												
Construction												

Figure 6: Anticipated Project Schedule

## ENGINEER'S OPINION OF PROBABLE COST – COMPOSITE SLIPLINING

JMT revised the cost estimate provided in the Phase 2 Technology Evaluation Memorandum to reflect information collected during the property valuation, environmental screening, and the Redzone inspection. In addition, costs were updated to include new quotations and estimates from contractors and vendors. The revised cost estimate for sliplining can be found in Table 3.



- ∞ The estimate now includes an additional 1,500 LF of the upper portion of the PCI.
  - It was assumed previously that this section of the PCI was completely rehabilitated by CCCPL under the previous contract. However, JMT's review of the rehabilitation in these areas showed active infiltration which could affect the conduits long-term structural stability.
  - In addition, the life span of geopolymer (or CCCPL) is significantly less than that of a newly sliplined pipe. Therefore, JMT recommends CRW consider sliplining these areas to increase the life span of the PCI.
- ∞ Due to a high probability of soil contamination, the cost estimates were revised to reflect a higher baseline of soil removal and replacement and groundwater treatment.
  - The baseline cost for soil removal and replacement and groundwater treatment assumes the soil from the bottom of the excavation to foot above the existing pipe will need to be removed and replaced with structural, clean fill.
- ∞ The cost for temporary construction easements from the Property Valuation Memorandum were incorporated.
- ∞ The unit cost estimate of grout for the annular fill was updated based on conversations with contractors for the specialty engineered grout that may be required due to high levels of infiltration. Unit costs for the material cost of the pipe were updated per a more recent quotation as well.

Table 3: PCI Sliplining – Engineer's Opinion of Probable Cost

Description	Opinion of Probable Cost	Probable Cost per Linear Foot (\$/LF)	Cost Range (\$/LF)
1. Upstream Pipeline (7,284 LF)	\$4.3M		
2. Downstream Pipeline (5,722 LF)	\$7.2M		
3. Bypass Pumping	\$0.7M		
4. Soil Removal and Replacement and Groundwater Treatment (Due to baseline and 50% of properties containing fully contaminated soil)	\$2.3M		
5. Miscellaneous Items	\$2.1M		
6. Contingency (20%)	\$3.2M		
7. Design and CM	\$2.0M		
Total Cost (Class 3) <sup>2</sup>	\$21.8M	\$1,675	\$1,592 - \$1,757

Assumptions made for the costs presented include:

- ∞ The probable cost per linear value assumes 50% of the properties require all access pit excavation material to be removed due to the presence of fully contaminated soil in addition to the baseline soil removal and groundwater treatment.
- ∞ Highest cost per LF value assumes 100% of the properties require all access pit excavation material to be removed due to the presence of fully contaminated soil.

<sup>2</sup> Class 3 cost estimates represent preliminary budget estimates according to the Association for the Advancement of Cost Engineers' guidelines for projects at a 10-40% maturity level.



- ∞ Lowest cost per LF value assumes 0% of the properties require all access pit excavation material to be removed due to the presence of fully contaminated soil. The baseline cost of soil removal and groundwater treatment is assumed.
- ∞ Minimal grout will seep into surrounding soils
- ∞ Bypass pumping of trunklines and laterals will be required for flows that exceed capacity of annular space.
- ∞ CRW will negotiate access to all sites in the design phase. Temporary construction easement costs are reflected from the Property Valuation Memo submitted by JMT.

A comparison of the engineer's opinion of probable cost provided in the Paxton Creek Interceptor Rehab Phase 2 Technology Evaluation Memo to the revised cost is shown in Table 4. As noted above, the Opinion of Probable Cost total sum and linear foot values are based on full contamination in 50% of properties.

Table 4: PCI Sliplining – Cost Revisions Summary

Memorandum	Opinion of Probable Cost	Probable Cost per Linear Foot (\$/LF)	Cost Range (\$/LF)
Phase 2 Technology Evaluation (Dec. 2018)	\$17.7M	\$1,540	\$1,360 - \$1,730
Phase 2 Rehabilitation Memorandum (Oct. 2019)	\$21.8M	\$1,675	\$1,592 - \$1,757

## ENGINEER'S OPINION OF PROBABLE COST – OPEN CUT PIPE REPLACEMENT

JMT revised the cost estimate provided in the Phase 2 Technology Evaluation Memo to include information gathered during the property valuation and environmental screening. In addition, costs were updated to include new quotations and estimates from contractors and vendors. The revised cost estimate for open cut pipe replacement can be found in Table 5.

- ∞ Due to a high probability of soil contamination, costs were revised to reflect a higher baseline of soil removal and replacement and groundwater treatment.
  - The baseline cost for soil removal and replacement and groundwater treatment assumes the soil in the lower portion of the trench from bottom of the excavation to one foot above the new pipe will need to be removed from the site and replaced with structural, clean fill.
- ∞ The costs for permanent easements and temporary construction easements from the Property Valuation Memo were incorporated.



Table 5: PCI Open Cut Pipe Replacement – Engineer's Opinion of Probable Cost

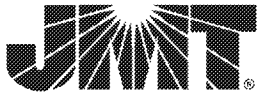
Description	Opinion of Probable Cost	Probable Cost per Linear Foot (\$/LF)	Cost Range (\$/LF)
1. Upstream Pipeline (~36-in)	\$4.5M		
2. Downstream Pipeline (~72-in)	\$6.8M		
3. Bypass Pumping	\$1.0M		
4. Soil Removal and Replacement and Groundwater Treatment (Due to baseline and 50% of properties containing fully contaminated soil)	\$14.8M		
5. Miscellaneous Items	\$2.7M		
6. Contingency (20%)	\$5.7M		
7. Design and CM	\$5.3M		
Total Cost (Class 4) <sup>3</sup>	\$40.8M	\$3,131	\$2,532 - \$3,731

Assumptions made for the costs presented include:

- ∞ The probable cost per linear value assumes 50% of the properties require all trench material to be removed due to the presence of fully contaminated soil in addition to the baseline soil removal and groundwater treatment.
- ∞ Highest cost per LF value assumes 100% of the properties require all trench material to be removed due to the presence of fully contaminated soil.
- ∞ Lowest cost per LF value assumes 0% of the properties require all trench material to be removed due to the presence of fully contaminated soil. The baseline cost of soil removal and groundwater treatment is assumed.
- ∞ Pipe connections including laterals, trunklines, and CSO facilities can connect by gravity without drastically lowering the pipe invert.
- ∞ No advanced restoration beyond typical pavement or grading and seeding is required.
- ∞ No significant utility conflicts or utility relocation required.
- ∞ The need for bypass pumping will be minimized by keeping the existing PCI and its lateral connections in service during the duration of construction. Bypass pumping will be required during construction of new piping to divert flows, or potentially at locations where the proposed sewer alignment will need to cross through the existing interceptor or laterals.

A comparison of the engineer's opinion of probable cost provided in the Paxton Creek Interceptor Rehab Phase 2 Technology Evaluation Memo to the revised cost is shown in Table 6. As noted above, the Opinion of Probable Cost total sum and linear foot values are based on full contamination in 50% of properties.

<sup>3</sup> Class 4 cost estimates represent preliminary budget estimates according to the Association for the Advancement of Cost Engineers' guidelines for projects at a 1-15% maturity level.



*Table 6: PCI Open Cut Pipe Replacement – Cost Revisions Summary*

<b>Memorandum</b>	<b>Opinion of Probable Cost</b>	<b>Probable Cost per Linear Foot (\$/LF)</b>	<b>Cost Range (\$/LF)</b>
Phase 2 Technology Evaluation (Dec. 2018)	\$32.9M	\$2,530	\$1,690 - \$3,640
Phase 2 Rehabilitation Memorandum (Oct. 2019)	\$40.8M	\$3,131	\$2,532 - \$3,731

## **RECOMMENDATIONS**

Based on further evaluation of the two installation techniques (trenchless sliplining versus open cut), JMT recommends CRW rehabilitate the PCI utilizing the sliplining method as the primary approach. The rehabilitation recommendation uses a composite scenario of circular sliplining upstream of CSO-28 and non-circular sliplining for the remainder of the PCI; with exception of the siphon. Due to the large quantities of infiltration, specialty grout may be required to displace the groundwater and achieve a fully structural rehabilitation. As a trenchless technology, sliplining reduces risks and concerns of environmental contamination in the area. Excavations will be limited to access pits and lateral connections, which requires considerably less excavation than the trench required for a new parallel pipe. This approach will also minimize impact to nearby property owners and stakeholders. In addition, sliplining will not require the purchase of new permanent easements. This approach will reduce some capacity of the PCI; however, the improved hydraulic coefficients with new FRP pipe should be considered.

A new parallel sewer installation to the PCI would take a considerably longer for CRW to fully implement due to the amount of property acquisition for new easements, further analysis of environmental conditions, and a longer construction period. Further evaluation and sampling may be required to assess the environmental contamination in the area and determination whether the material can be re-used on-site. A new pipe would, however, enable CRW to increase capacity and potential storage in the pipeline to mitigate CSO challenges related to the Long-Term Control Plan. These benefits should be weighed before making an ultimate decision on new pipe construction versus sliplining. Should CRW decide to further pursue installing a new pipe in a differing alignment, a more detailed preliminary design and engineer's estimate of probable cost should be completed to define the desired route that limits property impacts and areas of higher environmental concern. In addition, a new pipe installation would ideally be coordinated with the Paxton Creek Restoration Master Plan Project which includes de-channelization of Paxton Creek by PennDOT. At the time of this memorandum, JMT was unaware of the progress in funding or support for that project and therefore this approach may not fit the timeline for this project.